## CLAIMS

**1.** A method for manufacturing magnetic field detection devices, said method comprising the operations of manufacturing a magneto-resistive element (10; 20) comprising regions having metallic conduction (13; 23) and regions having semi-conductive conduction (11; 31) characterised in that said method comprises the following operations:

- forming metallic nanoparticles (37) to obtain said regions with metallic conduction (13; 23);
- providing a semiconductor substrate (31);
- applying said metallic nanoparticles (37) to said semiconductor substrate (31) to obtain a disordered mesoscopic structure.

**2.** Method as claimed in claim 1, characterised in that said semiconductor substrate (31) is subjected to a chemical etching process to form pores (22) in said semiconductor substrate (31).

**3.** Method as claimed in claim 1 or 2, characterised in that said metallic nanoparticles (37) are applied to said semiconductor substrate, introducing said nanoparticles (37) in a solution (40) and applying said solution (40) to said substrate (31).

**4.** Method as claimed in claim 3, characterised in that it is employed in a process of capillary condensation of said solution (40) in the pores (22) of said semiconductor substrate (31) to obtain said metallic regions (23).

**5.** Method as claimed in claim 3, characterised in that it is employed in a process of electrochemical deposition in the pores (22) of said semiconductor substrate (31) to obtain said metallic regions (23).

**6.** Method as claimed in at least one of the previous claims, characterised in that to perform said

chemical etching process of the semiconductor substrate (31), to said substrate (31) is applied a porous template (38), in particular a template of porous alumina.

**7.** Method as claimed in claim 6, characterised in that said chemical etching uses an electrolytic solution (32) able to etch said semiconductor substrate (31) and that said electrochemical solution (32) is progressively replaced by the solution (40) containing metallic nanoparticles (37) always leaving the surface of the semiconductor substrate (31) immersed, to prevent ambient air or gas from penetrating in said pores (22).

**8.** A method as claimed in one or more of the previous claims, characterised in that it further comprises a step of thermal annealing of said magnetoresistive element (20) to create nanorods in said pores (22).

**9.** Method as claimed in claim 1, characterised in that in said step of providing a semiconductor substrate, said substrate (31) is grown with a growth process and the step of applying said metallic nanoparticles (37) provides for co-evaporating said particles (37) during said process of growing said substrate (31).

**10.** Method as claimed in claim 9, characterised in that said growth process is a sputtering process.

**11.** Method as claimed in claim 9, characterised in that said growth process is a Chemical Vapour Deposition process.

**12.** Method as claimed in at least one of the previous claims from 1 through 11, characterised in that said substrate of semiconductor material (31) is obtained by means of a semiconductor selected among silicon, germanium, indium antimonide, mercury

telluride, indium arsenide, carbon titanate, gallium arsenide, silicon carbide, gallium phosphide, gallium nitride and alumina.

**13.** Method as claimed in at least one of the previous claims from 1 through 12, characterised in that said metallic nanoparticles (37) are of a metallic material selected among gold, silver, aluminium, gallium, indium, copper, chrome, tin, nickel, iron, platinum, palladium, cobalt, tungsten, molybdenum, tantalum, titanium, permalloy.

**14.** A method as claimed in one or more of the previous claims, characterised in that said semiconductor substrate (31) is laid on another insulating substrate.

**15.** Method as claimed in at least one of the previous claims from 2 through 14, characterised in that said chemical etching process to form pores (22) in the semiconductor substrate (31) forms through pores (22).

**16.** A device for detecting magnetic fields, of the type comprising a magnetoresistive element (10; 20) able to vary its resistance upon application of a magnetic field (H), characterised in that said magnetoresistive element (20) is manufactured according to the method as claimed in claims 1 through 14.

**17.** Device as claimed in claim 16, characterised in that said electrodes (14) are applied to the lateral surfaces of said magnetoresistive element (20) to apply a current (I).

**18.** Magnetic device comprising a spin valve, said spin valve (110) comprising a plurality of layers (111, 112, 113, 114, 115, 116, 117) arranged in a stack which in turn comprises at least one free magnetic layer (111) able to be associated to a temporary magnetisation (MT), a spacer layer (113; 133) and a

permanent magnetic layer (112) associated to a permanent magnetisation (MP), characterised in that said spacer element (133) is obtained according to the step of manufacturing a magnetoresistive element (10; 20) included in the method as claimed in claims 1 through 15.

**19.** Device as claimed in claim 18, as claimed in claim 1, characterised in that said spacer element (133) comprises a matrix (135) and nanoparticles (134).

**20.** Device as claimed in claim 19, characterised in that said matrix (135) is a matrix of dielectric material.

**21.** A device as claimed in one or more of the previous claims from 18 through 20, characterised in that said matrix (135) comprises a porous dielectric material, in particular porous alumina or porous silicon, and the nanoparticles (134) are contained in pores (136) of said porous dielectric material.

**22.** Device as claimed in one or more of the claims from 18 through 21, characterised in that it is configured to regulate its electrical properties through the composition of said spacer layer (133).

**23.** Device as claimed in one or more of the previous claims from 18 through 22, characterised in that it is employed in TMR applications.